United States
Department of
Agriculture

Forest Service

**Rocky Mountain
Forest and Range
Experiment Station**

Fort Collins,
Colorado 80526

**General Technical
Report RM-102**

Management of Western Coniferous Forest Habitat for Nesting Accipiter Hawks

Richard T. Reynolds

1983

USDA Forest Service
General Technical Report RM-102

August 1983

Management of Western Coniferous Forest Habitat for Nesting Accipiter Hawks

Richard T. Reynolds
Rocky Mountain Forest and Range Experiment Station[1]

Abstract

Availability of nesting sites can limit accipiter populations. Because accipiters nest in dense forest stands, any alteration that opens these stands is likely to lessen their desirability as nest sites. Tree growth and the associated changes in the vegetative structure of aging nest sites limit the number of years sites will be suitable. Therefore, prospective replacement sites should be selected within the core areas of home ranges before precommercial and commercial harvesting begins.

[1]*Headquarters is in Fort Collins, in cooperation with Colorado State University.*

Management of Western Coniferous Forest Habitat for Nesting Accipiter Hawks

Richard T. Reynolds

Management Implications

The sharp-shinned hawk (*Accipiter striatus*), the Cooper's hawk (*A. cooperii*), and the northern goshawk (*A. gentilis*), have such specific nesting habitat requirements that they are vulnerable to changes in forest stands resulting from timber harvesting. To maintain populations of these species in western conifer forests, the following recommendations[2] are proposed:

1. Uncut areas of approximately 4, 6, and 8 ha should be left around active nests for the sharp-shinned, Cooper's, and goshawk, respectively.
2. Because of tree growth and associated changes in the vegetative structure of nest sites, management of accipiter habitat must consider the turn-over of nest sites. Prospective replacement nest sites within the home range of each pair should be selected and managed accordingly.
3. Active and prospective nest sites should not be precommercially or commercially thinned, because this will result in reduced stand densities and deeper tree crowns.
4. To maintain nesting densities of the three *Accipiter* species equal to that found in Oregon, currently suitable nest sites should be provided at the following approximate densities: 20 sites per township (36 square miles, 9,324 ha) for sharp-shinned hawks, 5 per township for Cooper's hawks, and 4 per township for goshawks.
5. Further study should be oriented towards: (1) estimating the density of these species in other localities where forestry is changing the structure of forest stands, (2) confirming the suggested size and shape of uncut areas around nest sites, and (3) determining, with telemetry, the size and shape of home ranges, the types of habitats included within ranges, and the extent to which these habitats are used for foraging by these hawks.

Introduction

Reynolds (1979) and Reynolds et al. (1982) have shown that sharp-shinned hawks, Cooper's hawks, and goshawks in Oregon have specific nesting habitat requirements. They also found that this specificity makes breeding accipiter populations vulnerable to some forest management practices. Precommercial and commercial thinning decrease nesting habitat for the first two species; harvesting of mature forests decreases goshawk nesting habitat. If forest managers are to minimize the impacts of timber management on these species, they need: (1) an estimate of the number of nest sites required to maintain populations of each species in large areas, (2) to identify specific nesting habitats for accipiters, and (3) to include management of these sites in forest management plans.

The findings of Reynolds and Wight (1978), Reynolds (1979) and Reynolds et al. (1982) on the density of nesting pairs, the vegetative and physiographic structure of nest sites, and the within-season and annual patterns of use of a site by pairs of accipiters in Oregon are summarized here. Estimates of home range size and movements of the North American accipiter during breeding are reviewed and compared with some reliable estimates of size of home range for European accipiter. Finally, some recommendations on management of accipiter habitat are presented.

This paper presents a habitat management scheme that accounts for the intermixture and dispersion of nesting sites for each species as well as for the turnover of nest sites resulting from stand growth and associated changes of the vegetative structure. This scheme should provide land managers with the tools to: (1) identify active and potentially active nest sites; (2) produce and maintain the important structural elements within sites; and (3) distribute suitable nesting habitat over time and geographic area.

Although this research was done in Oregon, the underlying concepts and accipiter nesting behavior should be comparable throughout the western coniferous forests. Reports in the literature from the western United States and the preliminary findings of habitat studies of these species in Colorado support this contention.

Methods

Nests were surveyed during the nesting seasons (April through August) from 1969 through 1979. Aerial photographs (scale = 1:12,000 to 1:24,000) and topographical maps (1:24,000) were used to locate potential nest sites on the basis of topography and stand density (Reynolds 1982). To ensure an accurate determination of

[2]*The research upon which these recommendations are based was conducted under the auspices of the Oregon Cooperative Wildlife Research Unit: Oregon Department of Fish and Wildlife, Oregon State University, U.S. Fish and Wildlife Service, and the Wildlife Management Institute cooperating. It was funded in part by the Oregon Cooperative Wildlife Research Unit and USDA Forest Service, Pacific Northwest Forest and Range Experiment Station.*

the density of pairs of each species, two large, forested study areas (9,284 and 11,741 ha) were intensively searched for nests (fig. 1). Distance between nests of conspecifics was measured; because some pairs used alternate nest sites in different years, these distances were calculated yearly.

The methods used to quantify the vegetative and physiographic structure of nest sites are described by Reynolds et al. (1982). The vegetation sampling was designed so that the entire stand containing the nest tree could be characterized. Nest-site use patterns were determined by observations from blinds in the early nesting season and from locations of plucked prey, molted feathers, and accumulation of feces. Various behaviors were observed during visits to nest sites throughout the nesting period. Nest-site use patterns between two or more alternate sites were determined by following pairs through three to five breeding seasons (Reynolds and Wight 1978).

Nest Density and Spacing

Nests of each *Accipiter* species were found from near sea-level to near timberline. In the intensively searched study areas, nest densities were one goshawk nest per 2,750 ha, one Cooper's hawk nest per 1,992 ha, and one sharp-shinned hawk nest per 2,750 ha. Because of edge effect, however, these figures are only rough estimates of density. Home ranges of these species are large enough to make it probable that a study boundary would cut off portions of one or more range. Therefore, the size of these study areas could have been changed with little or no change in the number of nests included within the boundaries.

Distances between nests provide another estimate of density. The combined (years and study areas) mean nearest neighbor distances between nests of conspecifics were 5.6 km (range, 2.4 – 8.4 km) for goshawks, 4.7 km (range, 2.6 – 6.9 km) for Cooper's hawks, and 4.1 km (range, 1.8 – 6.0 km) for sharp-shinned hawks (Reynolds and Wight 1978).

Nesting Chronology

Goshawks and Cooper's hawks usually appeared in their nest sites in late March; sharp-shinned hawks arrived in late April. Mean clutch completion dates were May 6 for goshawks, May 14 for Cooper's hawks, and May 26 for sharp-shinned hawks. Date of nesting did not vary much with elevation. For each species, incubation lasted approximately 30-32 days. Young fledged about 36 days after hatching for goshawks, 29 days for Cooper's hawks, and 23 days for sharp-shinned hawks. After fledging, the young were fed by the adults, and remained in the vicinity of the nest for 30–50 days.

Nest Sites

Accipiter "nest sites" are defined as the forest stand containing the nest tree, including both the structural features of the vegetation (e.g., tree density, canopy

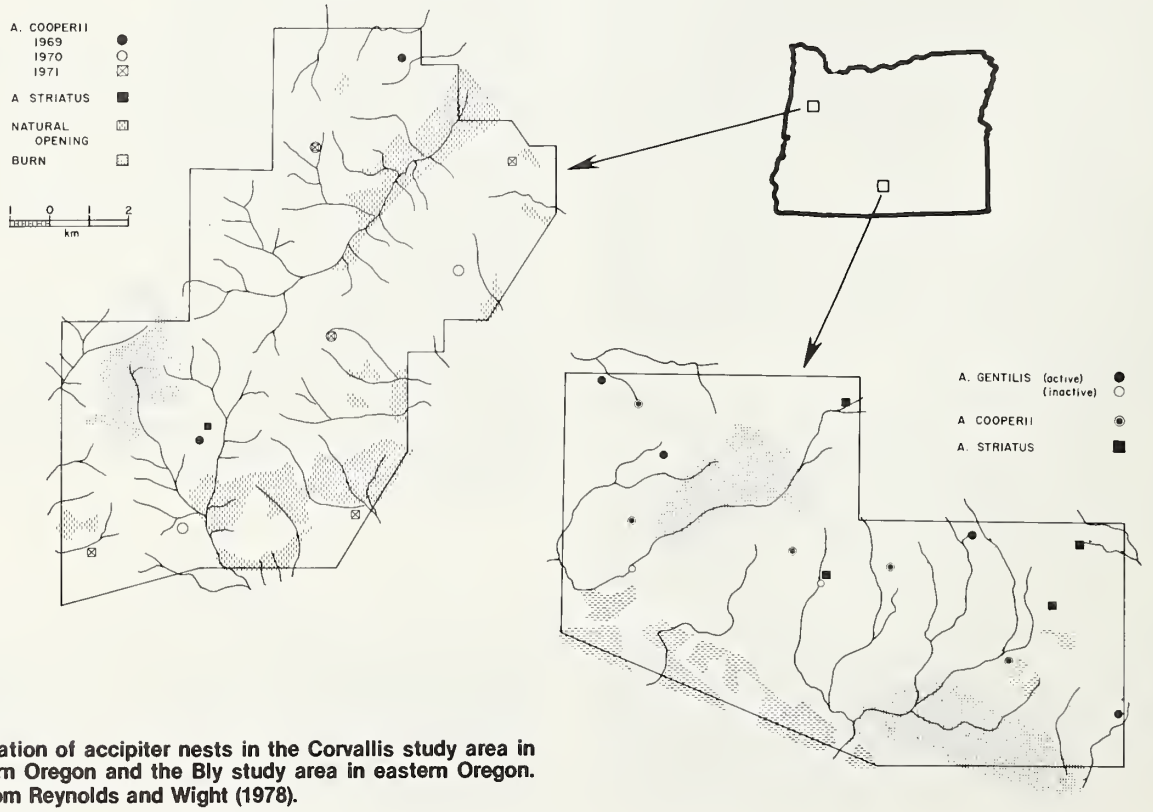

Figure 1. Location of accipiter nests in the Corvallis study area in northwestern Oregon and the Bly study area in eastern Oregon. Adapted from Reynolds and Wight (1978).

closure) and the land form (e.g., slope, aspect) within an area used by a pair and their fledglings during the nesting season (Reynolds et al. 1982). Thus, the boundaries of nest sites were determined by observations of the movements of the adults and fledged young as well as the locations of prey plucking areas and roosts. Nest sites in Oregon measured in this way ranged from approximately 4 ha for sharp-shinned hawks to 6 ha for Cooper's hawks, and from 8 ha to 10 ha for goshawks. Many nest sites had limits that coincided with boundaries between discrete vegetation structures (e.g., a dense patch of second-growth surrounded by mature forest) or tree species (a patch of fir surrounded by pine forests). Other sites had boundaries that coincided with topographic features (e.g., the tops of two parallel ridges on either side of the nest). The boundaries of some sites, however, did not coincide with vegetative or topographic features. These were typically in flat terrain and in large stands with homogeneous vegetative structure.

Bartelt (1974) used a different method to determine the size of the "nesting territory" of goshawks in South Dakota. He approached goshawk nests from various directions and noted the distance at which his approach elicited nest defense from the female. He found that the nesting territories were centered on the nests, and ranged from about 5 ha to 6 ha.

In Oregon, nest sites of the three species had similar physiographic but dissimilar vegetative structures. Most of the nests were on gentle to moderate slopes (0-30%) with northerly exposures (NW-NE) (Reynolds et al. 1982). In addition, most nest sites contained, or were adjacent to, quiet, ephemeral streams or springs. Nest trees typically were located on the lower portions of the slope near the water. In steeper areas, nest sites were frequently on benches or near the bottoms of stream headwalls. However, a few sites of each species were on slopes well above streams. Physiographic features in Oregon were similar to those for nests of the three species in Utah (Hennessy 1978) and for goshawks in both Colorado (Shuster 1980) and South Dakota (Bartelt 1974). In the area of Fairbanks, Alaska, however, the majority of 37 goshawk nests on hillsides had southerly aspects (McGowan 1975).

The most notable vegetative characteristics common to nest sites of the three species in Oregon were high canopy closure and tree density. Both factors, especially when combined with northerly exposures, produced shady, cool conditions below the forest canopy. The principal habitat differences among species were associated with the age of the stands: sharp-shinned hawks nested in from 25- to 50-year-old, even-aged conifer stands; Cooper's hawks in from 30- to 70-year-old, even-aged conifers with somewhat larger and more widely spaced trees; and goshawks in 150+ year-old conifer stands (fig. 2). Mean stand densities in sharp-shinned, Cooper's, and goshawk nest sites were 1,180 per ha, 907 per ha, and 482 per ha, respectively (Reynolds et al. 1982).

The overstocked conditions in sharp-shinned and Cooper's hawk nest sites result in intense competition

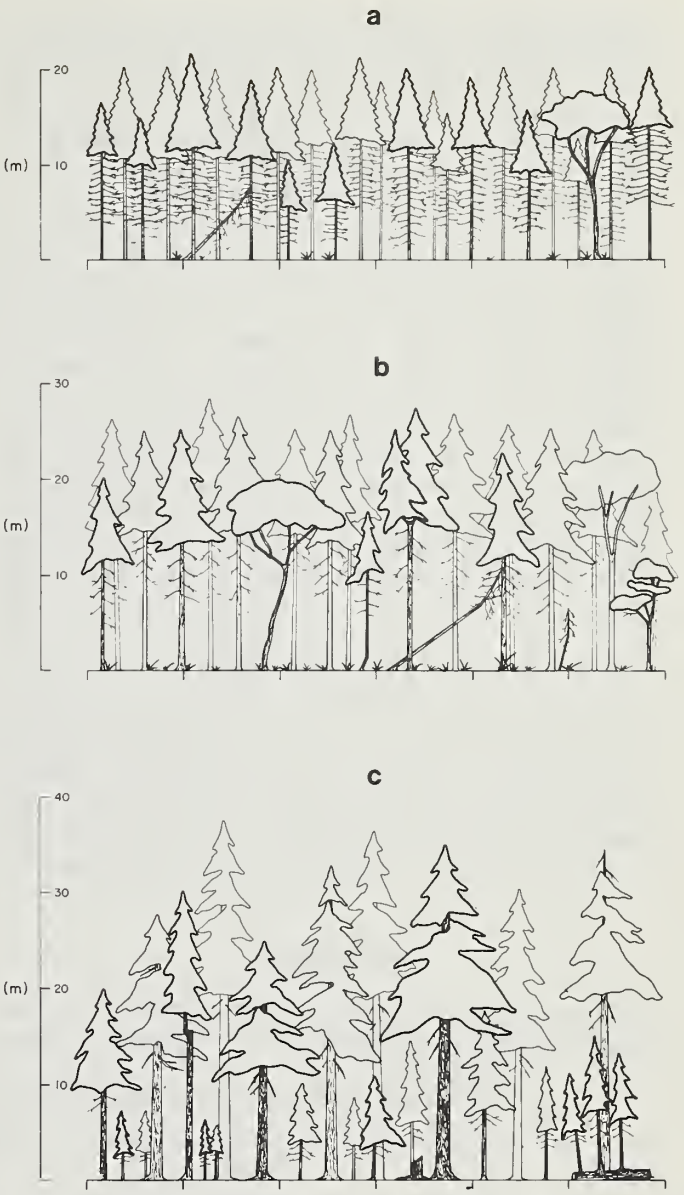

Figure 2. Schematic of the vegetation structure in typical nest sites of accipiter in Oregon. (a) sharp-shinned Hawk, (b) Cooper's Hawk, and (c) goshawk. Taken from Reynolds, et al. (1982).

for light. As a consequence, these stands had shallow canopies and many dead limbs on the boles below the crowns. Sunlight was sufficiently filtered to limit ground vegetation to mosses (*Eurhynchium* spp.) and sword ferns (*Polystichum munitum*). Goshawks require trees with big limbs to support their large nests, and, not surprisingly, tend to place their nests in one of the larger trees on their nest sites (Bartelt 1974, McGowan 1975, Reynolds et al. 1982). Goshawk nests in Oregon were in stands ranging from those with closed, mature canopies with few shade-tolerant understory trees to stands with more open, mature canopies and many understory trees.

During nesting, the activity of a pair (copulation, roosting, prey handling) was concentrated in the area upslope from the nest tree. Roosts, particularly toward the end of the nesting, were marked by accumulations of feces and molted feathers. Prey were plucked on tops of

stumps, logs, and large horizontal limbs below the canopy. Prey plucking areas were marked by accumulations of feathers, fur, and bones. Mean distances of the most frequently used prey plucking area from nest trees for sharp-shinned hawks was 41 m (range 21-52 m), for Cooper's hawks 54 m (range 42-86 m), and for goshawks 45 m (range 27-74 m) (Reynolds et al. 1982).

Nest sites were frequently used for more than 1 year. However, if sharp-shinned hawks and Cooper's hawks reused a nest site, they frequently built new nests, usually within 100 m of the old ones. Goshawks commonly used the same nests for many years, or alternated between two or more nests within a site. Many goshawks and a few Cooper's hawks irregularly used alternate nest sites. Of the three species, the goshawk showed the greatest site fidelity. For example, it was not uncommon for pairs to occupy a single nest site for 5 or more years, and one particular site was still active 10 years after its discovery. Cooper's and sharp-shinned hawks demonstrated much lower site fidelity. Of the Cooper's hawk sites, 27% and 11% were reoccupied the second and third year respectively; 40% of sharp-shinned hawk sites were reoccupied the second year, and none thereafter (Reynolds and Wight 1978). The lesser fidelity of the latter two species may be related to two factors. First, both are small and migratory (Wattel 1973) and may suffer losses to predators and accidents during migration, and, second, due to tree growth and a rapid nest site turnover, pairs of these two species are more often forced to resettle in more suitable stands.

Home Ranges

To investigate the effects of tree harvests on the foraging ecology of accipiters, it is important to know the size of their foraging areas, as well as the variety of habitats within ranges and the frequency at which each is used.

Home range size of accipiters during breeding has been estimated by: (1) observing marked birds or birds of known identity in areas about nests (Craighead and Craighead 1956); (2) observing adults leaving a nest area above the forest canopy and repeatedly noting the distance and direction traveled (Reynolds 1979); (3) assuming that ranges are circular and nonoverlapping, and using some measure of nest spacing (Newton et al. 1977, Reynolds 1979); (4) plotting the location of capture of marked prey whose remains were found at accipiter nests (Eng and Gullion 1962); and (5) monitoring the movements of adults using radio-telemetry (Marquiss and Newton 1981). Reynolds (1979) compared observations of direction and distance traveled by males leaving nest sites with measures of nest spacing, and found these estimates to be comparable for Cooper's and goshawks but not for sharp-shinned hawks (populations of this species were apparently not at the saturation level). Marquiss and Newton (1981) found that the theoretical mean range size based on nest spacing in sparrowhawks (*A. nisus*) determined by Newton et al. (1977) closely agreed with range size of radio-tagged males in the pre-egg laying and incubation periods. Marquiss and Newton (1981) also demonstrated that home ranges during breeding were centered around nests, and that ranges were smallest when the adults were attending the nest (pre-laying, incubation, and brooding) and increased as the food needs of the family increased.

Estimates of home range sizes in Oregon (Reynolds 1979) were considerably larger than the ranges reported for the same species in Michigan and Wyoming by Craighead and Craighead (1956) (table 1). These differences not only reflect the different techniques used,

Table 1.—Estimates of home range size among species of North American and European accipiter.

Species	Hectares	Explanation	Source
Sharp-skinned hawk (*A. striatus*)	204	plots of sight records	Craighead and Craighead 1956
	460	1.21 km radius of movement	Reynolds 1979
Cooper's hawk (*A. cooperii*)	173	plots of sight records	Craighead and Craighead 1956 ($\bar{x}$ for Wyoming and Michigan)
	1830	2.41 km radius of movement	Meng 1951
	1590	2.34 km radius ($\bar{x}$/2 distance between nests)	Reynolds 1979 (overall mean)
Goshawk (*A. g. atricapillus*)	212	plots of sight records	Craighead and Craighead 1956
	1979	2.51 km radius of foraging	Eng and Gullion 1962 (Fig. 3)
	2463	2.80 km radius ($\bar{x}$/2 distance between nests)	Reynolds 1979
Sparrowhawk (*A. nisus*)	1143	35 pairs/400 km^2	Kramer 1955
	1056	18 pairs/190 km^2	Kramer 1955
	1130	21.5 pairs/243 km^2	Tinbergen 1946
	480	9 pairs/43.5 km^2	Tinbergen 1946
	560	1 pair/560 ha	Tinbergen 1946
	305	telemetry, late nestling period	Marquiss and Newton 1981
Goshawk (*A. g. gentilis*)	2500	16 pairs/400 km^2	Kramer 1955
	3200	14 pairs/450 km^2	van Beusekom 1972
	3000	1 pair over many years	Brüll 1964

but also may reflect an actual geographic variation in range size. Meng (1951) reported that Cooper's hawks in New York foraged up to 2.4 km from the nest, a distance comparable to the observed movement of this species in Oregon. Eng and Gullion (1962) plotted the locations of known capture sites (drumming territories) of marked ruffed grouse (*Bonasa umbellus*) killed by a pair of goshawks and delivered to their nest. The goshawks' range was approximately circular and, although the hawks foraged primarily in an area of 1250 ha, they foraged up to 2.5 km and possibly beyond.

To further evaluate the estimates of range sizes of North American accipiter, they were compared to range size estimates of two European accipiter (table 1) and the relationship between accipiter body weight and range size was examined (fig. 3). The European sparrowhawk (*A. nisus*) is between the sharp-shinned and Cooper's hawks in both weight and home range size, and the European goshawk is similar to the American subspecies in weight and in home range size. Increased range size with increased body weight not only reflects the increased food demands of the larger hawks, but also the decreased density of their larger prey (Reynolds 1979).

In Oregon, the proportional use of habitat types for foraging was not determined. Observations of foraging hawks indicated, however, that a variety of habitats, from openings to dense forests, were utilized. Because accipiters are more easily seen in openings than in dense forest, it is easy to conclude that these hawks prefer edges or openings (e.g., see Wattel 1973). Marquiss and Newton (1981) found that the sparrowhawks in Britain used woodland more often than expected based on the proportion of woodland in their ranges, and Kenward (1982) found that goshawks in England spent 50% of the daylight hours in woodlands, although only 12% of their ranges were wooded.

Identification of habitat use by North American accipiter will require radio-telemetric monitoring. Hawks should be monitored in both winter and summer, and in

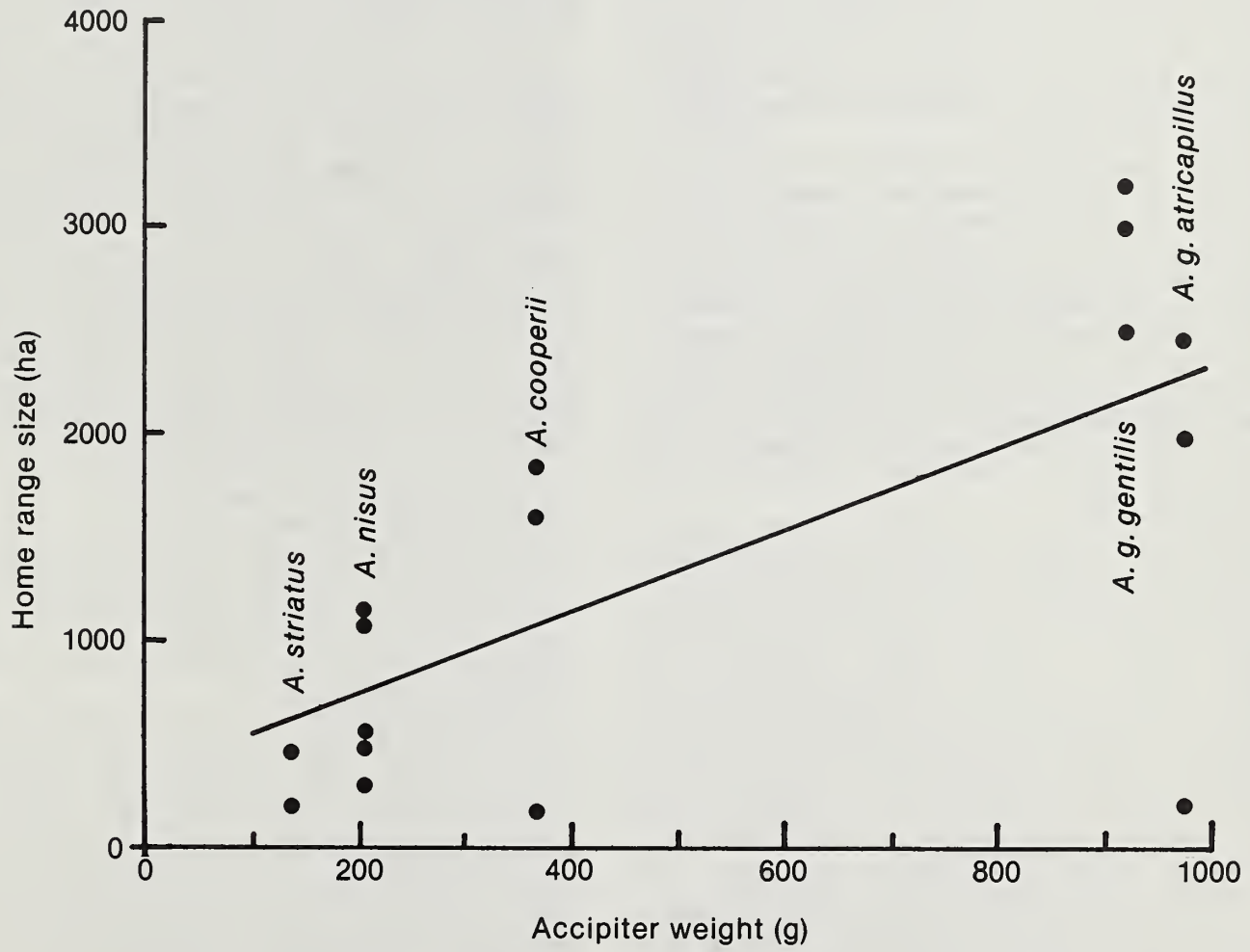

Figure 3. Relationship of estimated home range size to accipiter body weight. Weights are from Storer (1966) and Opdam (1975). Line fitted by least squares.

conjunction with measures of successional stage and age of habitat, vegetation structure, patch size, position in patch, and the spatial relationship of patches with respect to nests (summer) or roosts (winter).

Nest Site Management

To understand the habitat affinities of a species, it is necessary to know whether the species randomly settles into a habitat, or makes an active choice of a habitat. Reynolds et al. (1982) examined nest sites of accipiters by comparing the within- to among-species variation of the habitat variables within nest sites. The analysis showed a significantly greater variation among species, demonstrating that the association of these species with their habitat is at least not random. Reynolds et al. (1982) suggested that the use of dense stands by accipiters was adaptive in that vegetation protected the adults and fledged young from predators and provided shaded, relatively mild environments. If this is true, then accipiters probably choose nest sites on the basis of the stand's overall appearance (e.g., density, height, and presence of water), and, after settling into the stand, select a nest tree. The contention is that the entire nest stand—not just the immediate nest area—is important in accipiter nesting. Choice of a nest tree is secondary; if a pair settles into an acceptable stand, many suitable trees will be available.

If an accipiter nest is found in an area to be harvested, the entire nesting stand should be maintained. Protected areas about accipiter nests should include portions of the stand upslope from the nest containing the plucking and roost sites, the nest, and some portion of the stream (if one is present). The shape of uncut areas will be determined partly by the topography; they should be round or oblong in flat areas, and broad-based triangular or sectorial in steep terrain with the bisecting radius beginning below the nest and running up slope through the nest tree. Nest sites should not be isolated by silvicultural treatments (clearcutting, commercial thinning).

Accipiter nest sites in Oregon represent specific stages in forest stand succession. As a stand matures its structure changes. Thus, a stand is suitable for nesting for a limited time. Change is particularly rapid in sharp-shinned hawk and Cooper's hawk nest sites, because these stands are under intense competition for light—conditions resulting in rapid height growth and, through attrition, stem density reductions. Because of age-related changes, sharp-shinned hawk nesting habitat may become suitable habitat for Cooper's hawks and eventually for goshawks. To maintain nesting populations of accipiters, prospective nest sites with appropriate projected vegetative structure and physiography must be identified before they are precommercially or commercially thinned. Thinning prospective stands will result in reduced tree densities and deeper crowns, and may ultimately reduce their desirability as nest sites.

To maintain accipiter populations, nest sites must be dispersed throughout a management area. Assuming that 1.2 km represents the radius of the home range of a pair of sharp-shinned hawks, there would be approximately 20 pairs of sharp-shinned hawks per township (9,324 ha, 36 mi²), if the habitat was suitable and if filled to capacity. Providing two potentially active (1 active, 1 alternate site) and two prospective replacement sites for each pair would require a total of 80 sites per township. The distance between the centers or core areas (areas containing the active, alternate, and prospective replacement sites) of the home ranges should approximate the mean distance between nests of neighboring pairs. The potentially active sites and their replacements should be located no farther than 0.5 km apart.

Cooper's hawk pairs should also be provided two potentially active sites and two replacement sites. A mean distance of 4.7 km between nests of Cooper's hawks results in a density of 5 pairs per township. To maintain this density, 10 potentially active and 10 replacement sites should be provided. The active and replacement sites should be dispersed within the core areas in a manner as for sharp-shinned hawks. Sharp-shinned hawk sites that, because of age, are no longer suitable for this species, but lie within a Cooper's hawk core area, should be maintained as replacement sites for Cooper's hawks.

Goshawk pairs also should be provided two potentially active and two replacement nest sites. Because goshawks nest in mature or old-growth stands whose structure is changing relatively slowly, nest sites may be used for many years. However, considering the age of these stands, it is especially important to identify the replacement sites early. Because goshawks require closed or nearly closed canopies of mature trees, tree harvests within replacement stands are not recommended.

A mean distance of 5.6 km between goshawk nests results in an approximate density of four goshawk pairs per township. To maintain this density, eight potentially active sites and eight replacement sites should be provided. The active site and its replacement in each core area should be no farther than 0.5 km apart and not closer than 0.2 km. The distance between an active and alternate site should not exceed 1.0 km.

Cooper's hawk nest sites may be maintained beyond the suitable age for this species to serve as replacement sites for goshawks. However, if the intention is to provide goshawk nest sites by maintaining old sharp-shinned hawk and Cooper's hawk sites, the size of the original leave areas should meet the minimum required by the final target species.

It should be noted that the distance between pairs of hawks and their density is not a one to one relationship; that is, the density varies in proportion to the square of the distance between nests. For example, to manage for one-half of the density in the Oregon study areas, the distance between nests of Cooper's hawks will increase from 4.7 km to 6.7 km, and for goshawks from 5.6 km to 7.9 km. A doubling of the distance between nests may result in a 75% reduction in pairs. In cases where it is not feasible to provide the recommended number of sites, a preferred option is to forego providing alternate nest sites and their prospective replacements rather than opt for a more certain reduction in density by increasing the distance among pairs.

Literature Cited

Bartelt, Paul E. 1974. Management of the American goshawk in the Black Hills National Forest. 102 p. M.S. Thesis, University of South Dakota, Vermillion.

Brüll, H. 1964. Das Leben deutscher Greifvögel. Fisher Verlag, Stuttgart.

Craighead, John J., and Frank C. Craighead, Jr. 1956. Hawks, owls, and wildlife. 443 p. Dover Publications, Inc., New York, NY.

Eng, Robert L., and Gordon W. Gullion. 1962. The predation of goshawks upon ruffed grouse on the Cloquet Forest Research Center, Minnesota. Wilson Bulletin 74:227-242.

Franklin, Jerry, F., and C. T. Dyrness. 1973. Natural vegetation of Oregon and Washington. USDA Forest Service General Technical Report PNW-8, 417 p. Pacific Northwest Forest and Range Experiment Station, Portland, Oreg.

Hennessy, Stephen P. 1978. Ecological relationships of accipiters in northern Utah—with special emphasis on the effects of human disturbance. 66 p. M.S. Thesis, Utah State University, Logan.

Kenward, R. E. 1982. Goshawk hunting behavior, and range size as a function of food and habitat availability. Journal of Animal Ecology 51:69-80.

Kramer, V. 1955. Habicht und Sperber. Neue Brehm Bücherei Heft 158. Ziemsen Verlag, Wittenberg Lutherstadt.

Marquiss, M., and I. Newton. 1981. A radio-tracking study of the ranging behavior and dispersion of European sparrowhawks *Accipiter nisus*. Journal of Animal Ecology 51:111-133.

Meng, Heinz Karl 1951. The Cooper's hawk *Accipiter cooperii* (Bonaparte). 215 p. Ph.D. Thesis, Cornell University, Ithaca.

McGowan, Jerry D. 1975. Distribution, density and productivity of goshawks Interior Alaska. Alaska Department of Fish and Game. Federal Aid in Wildlife Restoration, Project Report W17-3, 4, 5, 6.

Newton, I., M. Marquiss, D. N. Weir, and D. Moss. 1977. Spacing of sparrowhawk nesting territories. Journal of Animal Ecology 46:425-441.

Opdam, Paul. 1975. Inter- and intraspecific differentiation with respect to feeding ecology in two sympatric species of the genus *Accipiter*. Ardea 63:30-54.

Reynolds, Richard T. 1979. Food and habitat partitioning among two groups of coexisting *Accipiter*. 116 p. Ph.D. Thesis, Oregon State University, Corvallis.

Reynolds, Richard T. 1982. North American accipiter hawks. p. 288-289. *In* Handbook of Census Methods for Terrestrial Vertebrates. David E. Davis, editor. CRC Press, Inc., Boca Raton, Fla.

Reynolds, Richard T., and Howard M. Wight. 1978. Distribution, density, and productivity of accipiter hawks breeding in Oregon. Wilson Bulletin 90:182-196.

Reynolds, Richard T., E. Charles Meslow, and Howard M. Wight. 1982. Nesting habitat of coexisting *Accipiter* in Oregon. Journal of Wildlife Management 46:124-138.

Shuster, William C. 1980. Northern goshawk nest site requirements in the Colorado Rockies. Western Birds 11:89-96.

Storer, Robert W. 1966. Sexual dimorphism and food habits in three North American accipiters. The Auk 83:423-436.

Tinbergen, L. 1946. De Sperwer als roofvijand van zangvogels. Ardea 34:1-213.

Wattel, Jan. 1973. Geographical differentiation in the genus *Accipiter*. 231 p. Publications of the Nuttall Ornithological Club, No. 13.

van Beusekom, C. F. 1972. Ecological isolation with respect to food between sparrowhawk and goshawk. Ardea 60:72-96.

Reynolds, Richard T. 1983. Management of western coniferous forest habitat for nesting accipiter hawks. USDA Forest Service General Technical Report RM-102, 7 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

Availability of nesting sites can limit accipiter populations. Because accipiters nest in dense forest stands, any alteration that opens these stands is likely to lessen their desirability as nest sites. Tree growth and the associated changes in the vegetative structure of aging nest sites limit the number of years sites will be suitable. Therefore, prospective replacement sites should be selected within the core areas of home ranges before precommercial and commercial harvesting begins.

Keywords: *Accipiter striatus, Accipiter cooperii, Accipiter gentilis,* wildlife habitat

Reynolds, Richard T. 1983. Management of western coniferous forest habitat for nesting accipiter hawks. USDA Forest Service General Technical Report RM-102, 7 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

Availability of nesting sites can limit accipiter populations. Because accipiters nest in dense forest stands, any alteration that opens these stands is likely to lessen their desirability as nest sites. Tree growth and the associated changes in the vegetative structure of aging nest sites limit the number of years sites will be suitable. Therefore, prospective replacement sites should be selected within the core areas of home ranges before precommercial and commercial harvesting begins.

Keywords: *Accipiter striatus, Accipiter cooperii, Accipiter gentilis,* wildlife habitat

Reynolds, Richard T. 1983. Management of western coniferous forest habitat for nesting accipiter hawks. USDA Forest Service General Technical Report RM-102, 7 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

Availability of nesting sites can limit accipiter populations. Because accipiters nest in dense forest stands, any alteration that opens these stands is likely to lessen their desirability as nest sites. Tree growth and the associated changes in the vegetative structure of aging nest sites limit the number of years sites will be suitable. Therefore, prospective replacement sites should be selected within the core areas of home ranges before precommercial and commercial harvesting begins.

Keywords: *Accipiter striatus, Accipiter cooperii, Accipiter gentilis,* wildlife habitat

Reynolds, Richard T. 1983. Management of western coniferous forest habitat for nesting accipiter hawks. USDA Forest Service General Technical Report RM-102, 7 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

Availability of nesting sites can limit accipiter populations. Because accipiters nest in dense forest stands, any alteration that opens these stands is likely to lessen their desirability as nest sites. Tree growth and the associated changes in the vegetative structure of aging nest sites limit the number of years sites will be suitable. Therefore, prospective replacement sites should be selected within the core areas of home ranges before precommercial and commercial harvesting begins.

Keywords: *Accipiter striatus, Accipiter cooperii, Accipiter gentilis,* wildlife habitat

Rocky Mountains

Southwest

Great Plains

U.S. Department of Agriculture
Forest Service

Rocky Mountain Forest and Range Experiment Station

The Rocky Mountain Station is one of eight regional experiment stations, plus the Forest Products Laboratory and the Washington Office Staff, that make up the Forest Service research organization.

RESEARCH FOCUS

Research programs at the Rocky Mountain Station are coordinated with area universities and with other institutions. Many studies are conducted on a cooperative basis to accelerate solutions to problems involving range, water, wildlife and fish habitat, human and community development, timber, recreation, protection, and multiresource evaluation.

RESEARCH LOCATIONS

Research Work Units of the Rocky Mountain Station are operated in cooperation with universities in the following cities:

Albuquerque, New Mexico
Flagstaff, Arizona
Fort Collins, Colorado*
Laramie, Wyoming
Lincoln, Nebraska
Rapid City, South Dakota
Tempe, Arizona

*Station Headquarters: 240 W. Prospect St., Fort Collins, CO 80526